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CONTENTS.

ON INSECTS

BY

E. A. ANDREWS, B.A.

Part IV.

(Continued from Vol. V, 1915, p. 11.)

The next order of insects with which we have to deal is the *Hymenoptera*. This group is remarkable, both on account of the high intelligence of many of its members, and of the high degree of specialisation to which many forms have attained, and, containing as it does the ants, bees, wasps, saw-flies, and parasitic ichneumon flies, is of great economic importance.

The members of this order are provided with two pairs of membranous wings, the hind pair usually slightly less than the front pair, which are generally colourless and transparent, but in some cases, as in the familiar carpenter bees, *(Xylocopa)*, may be pigmented. Sometimes, as in the worker ants, the wings are absent. Many members of this group have biting mouthparts, that is to say the mouth is provided with a labrum, or upper lip, two pairs of biting jaws, the upper pair being known as the mandibles, the lower pair as the maxillae, and a labium, or lower lip. In some of the higher forms, however, the lower pair of biting jaws (maxillae) and the lower lip (labium) are modified to form a sucking or lapping apparatus, while the upper lip (labrum) and upper pair of jaws (mandibles) retain their original biting form. This modification is found in the bee, the biting parts being mainly used for industrial purposes, and the sucking parts for feeding. A third feature of the insects of this order is the presence, at the hind extremity of the abdomen of the female, of a saw, as in the saw-flies, a sting, as in the wasps and bees, or an egg-laying apparatus, or ovipositor, as in the ichneumon flies. The changes of form undergone by the insects of this order during their life

history are great, and the four stages* described in Part II of this series of articles are distinctly defined. The larva in most cases takes the form of a white, fleshy, footless grub, as in the case of the wasp grub, with which all fishermen are familiar, and this grub is usually dependent on the parent for food, if not parasitic, when it is of course dependent on its host. In some cases, however, the larva is active and can forage for itself, as in the case of the saw-fly, whose larva is similar to a caterpillar in form, and feeds on the foliage of plants. The pupa is characterised by the fact that all the appendages of the adult body (antennae, legs, wings), which are developed in this stage, are not enclosed in the main part of the pupal case, but hang free from it, each being enclosed in a delicate skin of its own.

We have stated above that the order *Hymenoptera* is remarkable alike on account of the degree of specialisation found in the group, as well as on account of the high intelligence of many of its members, and before proceeding to describe the various divisions of the order, it may be of interest to discuss these questions in a general way. All know how powerful many members of this order are when on the wing, and must have often noticed the familiar digger wasps, which can fly away to their nests bearing in their grasp insects as large as themselves. Now the wings are worked by muscles which are attached by their other end to the skeletal portion of the thorax. These muscles become greatly developed in insects with powerful flight, and the skeletal portions need to be heavier and stronger. Hence we find that considerable modifications have been undergone by the thoracic segments of many *Hymenoptera*, resulting in the enlargement and strengthening of the thorax, which is in some species greatly developed. A further peculiarity of many *Hymenoptera* is the small "waist," which gives the abdomen a great range of movement and enables the insect to direct its sting or ovipositor with speed and great accuracy. This peculiarity is also found in the digger wasps. Such modifications are connected with the habits and economy of the different species. The digger wasp must be a powerful flyer in order that it may carry away the insects which serve as food for

* egg, larva, pupa, adult (see this Journal, Pt. II, 1913, p. 33).

its young, and it must also be able to place its sting with perfect accuracy in order to paralyse its prey without killing it, so that it may remain undecomposed until the young are ready to consume it. But specialisation has gone further than this in many *Hymenoptera*. Not only do we find that different species show special modifications, but also that various members of one species may be modified in different ways in accordance with different functions performed by them. Such a modification occurs for instance in the velvet ants (*Mutillidae*). The female spends the whole of her life on the ground, and is small and wingless. The male, on the other hand, is winged, and much larger. By means of his wings he is aided in his search for the female, and his larger size and greater power enable him to carry the female to a convenient place for mating. It is in the social insects, such as the ants and bees however, that this specialisation has been carried to a maximum. Each member of the colony has certain definite tasks to perform, and is so constructed as to be able to perform those tasks, and no others. In the ants, for example, we find several castes. The "workers" are active and wingless, with imperfect reproductive organs, and undertake the collection of food, the construction of the nest, and take care of the young. In some species there may be as many as three forms of worker. The "soldiers" are also active and wingless, and are provided with a large head and formidable jaws. They, like the workers, do not reproduce their kind. The adults, or reproductive individuals, have perfectly developed reproductive organs and wings, and their sole function is to reproduce and disseminate the species. One of the most curious instances of specialisation is to be found in the honey-pot ant of Mexico. In this species certain of the workers are used as honey-pots, for the storage of honey collected by the ordinary workers. The latter, after feeding the hungry members of the colony, give the surplus honey to individuals which remain suspended from the roof of a special chamber of the nest. These individuals swallow the honey, and become distended to an enormous extent, and it is supposed that they act as living honey-pots, and store the food until it is required by the colony. Other honey-pot ants, belonging to a different tribe, are also known from

Australia and South Africa, the same peculiar specialised habit thus having arisen independently in different species and in different parts of the world. In the social bees, also, we find that certain members of a colony are modified as workers, while the queens, and drones (males), carry on the race. Specialisation has also occurred in the modification of the mouthparts, and in the special construction of the legs for the collection of pollen.

In addition to presenting us with wonderful examples of specialisation, the behaviour of certain *Hymenoptera* would lead us to believe that they were possessed of a great amount of intelligence, and had, moreover, solved the problem of the control of sex production. If we consider, for instance, the case of the bee, we find that the queen lays eggs which give rise to drones, workers, and other queens. The drones are the males, the queens the females, and the workers are imperfect females. All are contained, when young, in different sized cells in the nest, and no worker, drone, or queen is ever found in the wrong cell. When mating has taken place the seminal fluid of the male is stored in a special sac forming part of the generative organs of the queen, and the eggs are fertilised as they pass this sac. But a queen which has not been fertilised can lay eggs, and these all become drones. It is therefore believed that the males are produced from unfertilised eggs, the females from fertilised eggs, and that the queen can open or close the special sac, and lay male or female eggs at will. Again, the female eggs may produce either workers or queens, and this is regulated by the worker bees, who feed the larvae intended to be queens on a rich honey-like syrup, while those which are to produce workers are given a less nutritive mixture of pollen and honey, known as "bee-bread," so that development does not go so far as in the case of the queen. Further examples of the control of sex-production, and of the possession of a highly developed instinct which, if not intelligence, is remarkably like it, will be given when the divisions of the order are discussed in detail.

Mention of the fact that the queen bee can produce eggs without being fertilised by a male brings before our notice a phenomenon not uncommon in the insect world, and frequent in

the order under discussion, namely, that of "parthenogenesis." The term is derived from two Greek words meaning "virgin birth," and is applied to cases where a female gives birth to young without having had intercourse with a male. Parthenogenesis is of three kinds, all of which are found to occur amongst *Hymenoptera*. In the first kind the females which reproduce parthenogenetically give birth to both males and females, which can mate and produce females which again give birth, without having mated, to males and females. Such a form of parthenogenesis is found amongst the gall-flies, or gall-wasps, as they are better called. In the second kind of parthenogenesis only females are produced, and males are unknown, or produced so seldom that they are very rarely found. This form of reproduction is also found amongst the gall-wasps, and is common in saw-flies. The last kind of parthenogenesis is the one which we have already noticed in the case of the bee, in which eggs produced without mating give rise to males only, and is also known to occur amongst the ants and wasps. This phenomenon occurs amongst tea pests in the case of the tea aphis (*Ceylonia theaecola*).

A division of this order which is of great interest from the point of view of economic entomology is that which contains the parasitic insects, the gall-wasps, whose larvae are helpless grubs living in galls on leaves, and the ichneumons, and other parasites of insects, which lay their eggs on or in the victim, who is devoured by the resulting grub. These insect parasites may be beneficial or harmful, according as they parasitise injurious or useful species, and they will be discussed in greater detail later. They are of very varied habits. Some lay their eggs in those of other insects; some lay their eggs beneath the victim's skin, while others deposit them on the outside, leaving the newly-hatched larvae to bore their own way in; some parasitise the larvae of other insects, some the pupae, and others the adults; some even parasitise other parasites.

The order *Hymenoptera* is divided into two large and distinct sub-orders, which are sub-divided as follows:—

A.—**Sessiliventres**... with the abdomen broadly attached to the thorax.

This sub-order is divided into three families, all of which are plant-feeding insects, and contains the saw-flies.

B.—Petiolata ... with the abdomen attached to the thorax by a slender stem.

This sub-order is divided into three series :—

1.—Parasitica—with an extruded ovipositor and divided trochanter.*

This series contains eleven families, and includes the gall-wasps and ichneumons.

2.—Tubulifera... single trochanter and retrusible ovipositor, there are only three to five segments visible on the under surface of the abdomen.

This series contains only one family.

3.—Aculeata ... single trochanter and retrusible ovipositor, more than five

* The trochanter is the joint of the leg next to the basal joint.

segments visible on the under surface of the abdomen.

This series contains twelve families, and includes the ants, bees, and different kinds of wasps.

GREEN MANURES

BY

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AND

A. C. TUNSTALL, B. SC.

Part IV.

(Continued from Vol. V, 1915, p. 72.)

For the past few years there has been at the Tocklai Experimental Station a series of plots of green manure plants. It may be interesting and useful for planters to know something more about them than is afforded by the information which has been given from time to time in the descriptions of individual crops which have been published in this Journal.

The plots at Tocklai are for the following purposes :—

1. To demonstrate to visitors the growth of the green crops at present in use.
2. To investigate the best methods of using the green crops, i.e., to find out the most suitable time of sowing, amount of seed to sow per acre, whether the plants can be propagated successfully by cuttings, etc.
3. To test the suitability of plants obtained locally from jungle in the tea districts.
4. To test the suitability of plants obtained from other parts of the world.

In practice the first two purposes, in regard to the plants already tried, have been fairly well achieved. Demonstration plots have been grown throughout the season, and these have afforded information as to the best methods of growing certain of the plants experimented with.

LEUCAENA GLAUCA
(from a photograph by C. BALD, ESQ.)

Excessive wet was found to be distinctly harmful to the germinating seed in the majority of cases. Soy beans appeared to be particularly susceptible. Mati kalai and cowpeas were not so seriously affected. In the case of Java-Natal indigo very wet weather was distinctly beneficial. The same conditions were also favourable to the germination of *Clitoria cajanifolia*.

The best growing period for all the plants was about the middle of the rainy season. Earlier in the season the growth was liable to be checked by spells of dry weather, and later the attacks of insects assumed considerable importance.

Experiments in propagating herbaceous plants such as *Desmodium spp.*, *Tephrosia spp.*, *Clitoria cajanifolia*, and *Leucaena glauca* by cuttings were also carried out. The two latter plants were brought by the Chief Scientific Officer from Java. It was found that in all cases cuttings of these plants grew, and that the wetter the weather the better for the cuttings, but the experiments showed that in a given time the weight of green material grown from cuttings is less than that obtained from seed. Steep slopes and the faces of terraces may be planted from cuttings with advantage as there is much less risk than in the cases of seedlings of the plants being washed away, and the cuttings afford at once some protection from wash. Also in cases where seed is expensive or only a small quantity is available, the most economical plan is to sow the seed in carefully prepared seed beds and plant out cuttings from the seedlings.

In selecting new plants for trial this season special attention has been paid to those which may be likely to be useful for preventing wash. The weight of green material obtained during a given time has been a secondary consideration. Seed of plants likely to be suitable have been collected from all the tea districts and from the Mikir, Naga, and North Cachar hills. Most of the plants so collected belong to the genus *Desmodium*. Of these two, *Desmodium polycarpum* and *Desmodium retroflexum*, seem likely to prove specially satisfactory for the purpose in view. Both these plants are very common in the tea districts. *Desmodium concinnum* which very closely resembles *Desmodium polycarpum* was also

found satisfactory. The seed of these plants has been collected and will be sown next year for more seed. It is hoped that there will be sufficient this year to allow of the distribution of small quantities to seed growers.

A remarkable bean was collected from Nowgong. It is a perennial climber and its growth is so vigorous that it chokes out all other plants and even large trees are killed by it. A possible use for this plant may lie in keeping areas which have been cleared for planting free from other jungle until they can be planted. The suggestion has been put forward also that it may be used to kill out abandoned tea thus removing a favourable harbouring place for blights.

Various species of *Crotalaria* not hitherto tried have been grown, but the quantity of seed available was so small that no opinion can be expressed as to their value as green crops. Seed of this year's crop have been collected and the experiments will be continued.

Plots of seed of various kinds imported from abroad have been tried. Among these are cowpeas, several kinds of which were sown. The difference in rate of growth of the different kinds was so small as to be negligible but acclimatised seed in all cases gave very much heavier crops than seed freshly imported. A number of varities of cowpeas are sold in the bazaars of Bengal under the name of borbotti. The green pods which resemble French beans are used as a vegetable.

A few seeds of *Desmodium uncinatum* were received from an explorer in Texas. These germinated and about half a dozen plants were raised. Seeds of these will be collected and sown next season.

Messrs. F. H. Brunning, Australian seed merchants, have kindly sent a consignment of seeds for trial at the suggestion of Messrs. Miller & Co. of Colombo. Seed of many plants of possible utility as cold weather crops are included and plots have been prepared for trial during this cold season.

Specimens of all the common leguminous shade trees are being planted, as occasion offers, along the roads at the Tocklai Experimental Station and at Borbhetta. For this purpose nurseries were

prepared and many specimens are now growing well. It is hoped that later on these trees will be of considerable interest to planters visiting the station.

A series of interesting experiments on the manuring of green manure crops has been carried out at Borbhetta, a description of which is the subject of a separate article.

The area at present devoted to the trial of green manure crops will be considerably extended next year, and arrangements are being made for growing a limited quantity of seed of new plants which have shown promise. This seed is intended for distribution to seed-growers so that the latter may grow large supplies and place them on the market.

EXPERIMENTS WITH PHOSPHATIC MANURES ON GREEN CROPS.

There has been started this year on the Association's land at Borbhetta a series of experimental plots for green crops. The plots are so arranged that each particular crop occupies six plots of equal area, which receive different manurial treatment, but are otherwise as nearly as possible identical, and receive exactly the same cultural treatment at the same time.

These experiments will be carried on for some years with several objects, but already some results of interest have been obtained, particularly with regard to the relative quickness of action of different forms of phosphatic manure.

The results are tabulated below, taking the crop on the plot receiving lime, sulphate of ammonia, and sulphate of potash, but no form of phosphatic manure, as 100.

TABLE I.

	Moong dal.	Mati kalai.	White cowpeas.	Brown cowpeas.	Dhaincha.	Mean of 5 plots.	Average increase per cent. due to phosphatic manure.
Limestone, Sulphate of Ammonia, Sulphate of Potash.	100	100	100	100	100	100	...
Limestone only .	112	94	109	84	100	98	...
Limestone, Sulphate of Ammonia, Sulphate of Potash. Ephos Basic phosphate.	198	100	182	99	111	138	38
Limestone, Sulphate of Ammonia, Sulphate of Potash. Degelatinised bones.	234	189	336	262	300	264	164

TABLE I—*(continued.)*

	Moong dal.	Mati kalai.	White cowpeas.	Brown cowpeas.	Dhaincha.	Mean of 5 plots.	Average increase per cent. due to phosphatic manure.
Limestone, Sulphate of Ammonia, Sulphate of Potash. Superphosphate.	523	275	352	333	380	373	273
Limestone, Sulphate of Ammonia, Sulphate of Potash. Basic slag.	478	332	352	283	418	373	273

The figure in the last column give a fairly accurate idea of the relative efficiency of the four forms of phosphatic manure for increasing the normal growth of green crops on this particular soil.

The figures are strictly applicable only to these crops and to this soil; but the results on other crops within the same time would no doubt be in the same direction, and the relative increase for each of these phosphates manures would probably be similar, though the actual and percentage increases might not be so great.

The soil, too, is of a type very common in the tea districts, belonging to what is referred to in "Suggestions for the manurial treatment of tea soils" as the "2·4 type," that is, "fine sand" forms the largest fraction of the soil, with "fine silt and clay" present in next highest proportion.

Chemically, its main features are its acidity and its marked deficiency in phosphoric acid; the amount of nitrogen and organic matter present are also low. These characteristics are common to a very large number of tea soils. The results, therefore, are of general interest, as they may be expected to apply to most tea soils of the same mechanical type, and in part at least to other soils.

The table brings out the following facts:—

(1) Ephos basic phosphate has a disappointingly small effect. From such work as can be done in the laboratory, much was expected from this compara-

tively cheaply produced manure, but this practical trial shows that it is very slow in action, and unsuited for the purpose of growing a big green crop on this class of soil. It is hoped that a trial over a long period will show that it is of value for its lasting properties and for other types of soil.

(2) Steamed bone meal has given a result much more rapidly than was expected. The particular form of bones used (degelatinised bones) is expensive, and its immediate effect for the same price does not compare well with superphosphate and basic slag.

Further experiments will be made with cheaper forms of bone.

(3) Basic slag and superphosphate are seen to have a roughly equal and very great effect. The figures shown are remarkable, and the appearance of the crops themselves was still more striking.

The basic slag and superphosphate plots began to show up at a very early stage. For the first three weeks the superphosphate plots were perhaps slightly the better all round, but at the end of six weeks, when the crops were weighed there was, as shown in the table, no difference on the whole.

At normal prices these two forms of manure work out at about the same price per lb. of phosphoric acid, with a saving in freight in the case of the much less bulky " concentrated superposphate " ; but at normal prices basic slag is to be preferred on the acid tea soils, on account of its basic character. On these soils the strongly acid superphosphate is better avoided, if possible, on theoretical grounds. In the experiment under consideration the very light dressing of lime given (10 mds. crushed limestone per acre) still left the soil strongly acid, and, as has been shown, superphosphate gave an average result equal to that of basic slag. At

present war-prices, a big saving may, therefore, be affected by the use of superphosphate instead of basic slag.

It is now becoming a common garden practice to apply at least light dressings of lime, and where this is done, superphosphate may usually be used with confidence; and, on most soils, even where no lime has been applied better value will be obtained from the use of superphosphate in preference to basic slag, while this latter continues at its present high price (see Tables II and III).

(4) In the absence of phosphoric acid no increase in crop has been obtained from the use of nitrogenous and potassic manures.

This result is by no means of such general application as those already discussed, but would only be true of soils very deficient in phosphoric acid, and for certain crops.

On a very large number of soils, however, it would be found that the *full* benefit of nitrogenous manuring is not obtained unless some form of phosphatic manure is also applied, even in the case of such a crop as tea.

Experiments were made also with sunn hemp, soy beans, indigo, boga medeloa, and *Tephrosia purpurea*, and, while these all gave results in the same direction as the crops which have been considered, for different reasons these plots were unsuitable for exact measurement. The sunn hemp was so badly attacked by hares that at the end of six weeks, on four beds all the plants, and on the other two beds most of the plants, were kept eaten down to two or three inches. On the basic slag and superphosphate plots growth was comparatively so rapid in the early stages that many plants reached a height at which the hares no longer attacked them, so that on these two plots fair crops were obtained. It is curious and interesting to note that no one of the other nine crops was attacked at all.

After many attempts at sowing, only a few plants of soy beans could be obtained. This plant appears to be quite unsuited to the particular soil. It is possible that it would have grown had the land been limed more heavily.

Indigo germinated unevenly on account of poor seed. Boga medeloa and *Tephrosia purpurea* are both far from maturity at six weeks, and these plants were retained to obtain an idea of the effect of the manures after a longer growing period.

On all these plots it could be seen by the eye, that at six weeks the results were about the same as in the case of the plants whose crop results are quoted.

In all cases samples of the green crop plants were taken for the determination of moisture. The results are not worth quoting in full, but it may be said that for each crop the percentage of water was about the same whatever the manurial treatment, and that the increased weight obtained was not, as is sometimes thought, merely an increase in water content of the plants.

The table that follows shows the cost of the phosphatic manures. The quantities of manure used for trial were largely in excess of what is usually applied. This was merely to compare the various manures. Whether it would pay to use such big dressings in practice can only be determined by trial on each particular soil, but is probable that better paying results would be obtained by the use of much smaller applications.

The tables, however, are useful as showing the relative cost for equal efficiency, of the various manures.

TABLE II.

COMPARATIVE COST (AT AVERAGE PRICES BEFORE THE WAR) OF THE MANURES ACTUALLY USED IN THE EXPERIMENTS.

Manures.	Approximate rate per acre used.	Prices in Calcutta per cwt.	Cost of manure per acre.	Cost in annas of each 1% increase in green crop per acre.
Ephos basic phosphate ...	4 cwt. ...	Not quoted	.....	.....

TABLE II—*(continued.)*

Manures.	Approximate rate per acre used.	Prices in Calcutta per cwt.	Cost of manure per acre.	Cost in annas of each 1% increase in green crop per acre.
Bone flour (degelatinised bones)	4 cwt. ...	Rs. 5 4 0	Rs. 21 0 0	2·06
Superphosphate (concentrated)	3 cwt.	Rs. 8 4 0	Rs. 24 12 0	1·33
(Basic slag) 18–20% ..	6½ cwt. ...	Rs 3 4 0	Rs. 21 12 0	1·24

TABLE III.

COMPARATIVE COST OF MANURES OF KINDS OBTAINABLE AND PRICES RULING IN OCTOBER 1915.*

Manures	Approximate rate per acre used	Prices in Calcutta per cwt.	Cost of manure per acre.	Cost in annas of each 1% increase in green crop per acre.
Ephos basic phosphate ...	4 cwt. ...	Rs. 4 13 0	Rs. 19 3 0	8·08
Bone flour (degelatinised bones)	4 cwt. ...	Rs. 6 8 0	Rs. 26 0 0	2·55
Superphosphate (20–22%) ...	5¾ cwt. ...	Rs. 3 12 0	Rs. 21 9 0	1·26
Basic slag (14–16%) ...	8 cwt. ...	Rs. 4 0 0	Rs. 28 0 0	1·64

* In the cases of superphosphate and basic slag equivalent quantities of less concentrated manures than those mentioned in Table II, had to be used as no other kinds were obtainable.

G. D. H.
H. R. C.

ADDRESSES TO DARJEELING PLANTERS.

At an Extraordinary General Meeting of the Members of the Darjeeling Planters' Association, held on the 24th of July 1915, Dr. G. D. Hope, the Chief Scientific Officer of the Indian Tea Association, addressed the Meeting as follows :—

MR. PRESIDENT AND GENTLEMEN,

Since I had the pleasure of addressing you here last year, the work of the Department has been continued on the same lines as formerly, and, except that I introduce to you the Entomologist, who is paying his first visit to this district, I have no new mission and I do not intend to address you at any length.

During the past year three of the subjects which have engaged our attention have been pruning, spraying, and manuring, and a pamphlet has been published on each of these subjects.

I would like to say again something on the subject of pruning, because I think it is a most important garden operation, and though I have heard the contrary opinion expressed in this district and elsewhere and have often seen work which presumably indicates that a contrary opinion is held, yet I cannot understand why the immense importance of pruning is not realized as fully as it should be.

The criticism may be launched in this district at our views and statements on pruning that they have been formed and written, if not specifically, at any rate actually, with reference to indigenous bushes and to conditions which obtain in the plains, but I would point out that the principles on which the methods we advocate are based, which are discussed in the earlier part of our pamphlet on pruning, are matters of scientific fact, and cannot well be entirely disregarded in any pruning of bushes for leaf. I am most anxious that they should be thoroughly understood here, because I feel that, if applied in the right way and with the local experience which you have, they will prove successful, and will eventually supersede the

present methods of pruning, which are often based on no principles beyond that of economy and that of following the path of least resistance in dealing with labour.

You may remember that last year I advocated two modifications of the pruning done in this district, first that bushes should not be pruned so often, and secondly that a method of pruning should be adopted which would result in the production of bushes with fewer and stronger branches.

With respect to indigenous or good jat hybrid bushes, of which there is a considerable area in these districts, particularly at the lower elevations, I would recommend you to adopt exactly the methods of thinning out, cleaning out, and taking-out-of-centres, and so on, which are now carried out on many plains gardens at the time of top, medium, or heavy pruning, giving the bushes the opportunity of building up new frames by leaving them unpruned for the necessary length of time.

I confess it is unfortunately more difficult to establish a method of pruning China bushes so that they shall produce fewer and stronger bearing branches, and I see that the difficulties which have to be faced are great. But you will agree with me that it is not difficult to find large areas of China and poor jat tea in these districts where the centres of bushes are, in any planter's opinion, too full of branches and too full of dead wood, and consequently too full of moss, earth, and dead leaves, which lead to disease. In China bushes there is not the same objectionable weakness of outside as compared with centre branches as is found in indigenous bushes, because the China plant is by habit more bushy in type, and therefore, I do not think that hard pruning of centre as compared with outside branches is so necessary. The great tendency of China bushes however is to multiply branches to an objectionable extent, resulting in great congestion of the centres, which is a bad state of affairs from every point of view. This tendency might profitably be checked in pruning at certain stages by removal of some branches from the bushes altogether, particularly from the centres. This should be done by taking out branches completely, either as low down as possible on the collar or at some

place higher up but always at a point where they join another branch, so as not to form a snag.

These ideas may be of use to you in helping you to devise a better scheme of pruning than exists in this district at present.

With regard to unpruned tea everything that I have seen on this visit to your district confirms the opinions I expressed last year of its value. I do not feel that I am competent to express an opinion on the relative merits, which should be based on suitability to the district, of entirely unpruned or "skiffed" tea, but for the purpose I had in view in advocating more unpruned tea "skiffed" and entirely unpruned tea fall in the same category.

With regard to manuring, I would say this, that the Department is following, and is anxious to follow very closely, the results obtained from the use of manures in this and other districts, and to correlate them as far as possible with types of soil. It is very encouraging to find that manuring with artificials is now definitely and successfully taking its part in the operations carried out on several estates in the district, and that the results confirm what I have said of the value of manures.

On such estates as I have visited during this tour I have made a point of taking a special note of the soil, and I think it is probable that in this district soils will be found which can be classified under all the types which are mentioned in our recently published article of manuring. These types undoubtedly require very different manures and probably also soils of the same type require different manures according as they are situated in the hills or in the plains though the latter is a point which has yet to be determined. At present owing to our having received very few recent analyses I can do no more than guess at the type of the soils in this district. I will therefore ask you to help the Department to a knowledge of your soil which will enable us to give you the best advice we can, by furnishing us with soil analysis.

If an analysis is sent to us, it is in most cases possible at once to suggest types of manures which will give good results, and what is equally important, to correct mistakes in manuring if they have been made, as sometimes happens. Three analytical firms in

Calcutta now analyse soils for members of the Indian Tea Association according to a specification laid down by me. They charge Rs. 56 for this analysis which is both chemical and mechanical.

I have noticed particularly during this visit that the soils of this district show that tendency towards acidity which is an almost universal characteristic of the tea soils of North East India. Although the soils of the Darjeeling district contain a reasonable quantity of total lime they evidently lack carbonate of lime, which would effectively check a tendency towards acid conditions. Lime is a corrective for this and the extent of the lime requirements of a soil can be measured, roughly certainly, but sufficiently accurately to form a useful guide, by analysis according to a scheme I have drawn up, which is now in the hands of Calcutta analysts.

Another point to which I would draw your attention is the importance of adequate drainage of hollows in the slopes and of place where there is a seepage of water. It is not always an easy matter to drain such places but it may be interesting for you to know that the way this would be done in Java would be first of all to ensure a satisfactory outlet for water by means of deep narrow drains cut straight down the hill-side, and then into this a series of contour drains would be cut with a very slight gradient, and if it were necessary to take the water from such a place away from the ground immediately below it, a larger contour drain would be used for the purpose, but in any case the contour drain is allowed to empty itself at as short a distance away as possible into the drain which carries the water straight down the hill-side.

Finally, I would ask you to remember that all the garden operations which I have touched on to-day and many others are inter-dependent. You will not get the best results from one operation, however well and intensively it is carried out, unless due attention is paid also to the others.

I cannot give you a better illustration of this than in connection with manuring and pruning. You will not get the best results from the use of manures unless the bushes to which they are applied are free from dead wood and contain only those branches into which you would wish to direct energy of growth.

Conversely in manuring you have a method of accelerating and invigorating new growth and the best results of correct pruning, and the best new frames will only be obtained by manuring your bushes so as to obtain the new and vigorous growth which you require.

Mr. E. A. Andrews, Entomologist of the Indian Tea Association, then addressed the Meeting as follows :—

MR. PRESIDENT AND GENTLEMEN,

I propose to address you to-day on the subject of Insect Control, and to point out, so far as I can in a short address, the various means by which the attacks of insects may be modified, indicating at the same time the methods which, from what I have been able to see of your district during the past few days, I think could be most profitably employed against the particular pests with which you have to deal. The various practices followed to-day in the control of insect pests may be considered under three heads :—

First the utilisation of any natural means at our disposal, *e.g.*, parasites and predators, when known ;

Second artificial methods, such as collecting, and the utilisation of insecticidal preparations ;

Third cultural methods, or modifications of agricultural practice suggested by a knowledge of the habits and economy of the pest concerned.

Nature always tends to preserve a balance, and various controlling influences are continually at work which under normal conditions determine the sphere of action of any particular organism, and which, when a redistribution of things is brought about by man's interference, tend to reproduce a natural state of affairs. The first, and greatest, controlling factor is climate. To take an extreme case insects which flourish in the tropics are unable to live in arctic regions, and vice versa. One insect may flourish in one district, where the climatic conditions favour its development, while in a district quite near but with different climatic conditions, it may be unable to do more than exist. In a district where the climate is favourable to the development of a pest, a planter who

is endeavouring to fight that pest will be handicapped by climatic influences; in a district, on the other hand, where climatic influences are unfavourable to the insect, they will materially assist him in getting the better of the latter. Take, for instance, the case of the tea mosquito (*Helopeltis theivora*). This pest is universally distributed throughout the tea districts of North-east India, and given certain climatic conditions is capable of increasing to an enormous extent. In districts such as the Duars and parts of Cachar, where the climatic conditions are invariably favourable to its development, this insect has become one of the planter's greatest enemies, but in parts of Assam, where the climate is as a rule less favourable, the pest only attains serious proportions when climatic conditions tend to be somewhat similar to those in the districts mentioned above. Planters in the latter district are assisted by climatic influences, while those in the former district are handicapped.

The topography of a district also exerts a controlling influence on insect life. Certain insects are not found above or below certain elevations, some only flourish in the open plains, others under the shelter of the hills; rivers, hills, and belts of jungle will often limit the spread of insects, and jungle often affords shelter to insect pests during critical periods of their life histories.

The above-mentioned natural influences are largely beyond our control, but there is a third influence of which we can take advantage to a certain extent. Insects are kept down in numbers by parasites and predators, and since much has been written by various people on the subject of "parasites" of tea pests which shows that misconceptions have arisen in various quarters as to the meaning of these terms, it may not be out of place to define them here. A parasite is an organism which undergoes a part at any rate of its life history in the body of another organism. A predator, on the other hand, is an organism which utilises other organisms as food, but which is free living throughout its existence. The former, since it relies on completing its growth within its host, as the insect attacked is called, must go through its life history at a more rapid rate than the host, in order to ensure that the latter will not die before the parasite is ready to emerge. Thus it comes

about that most parasitic insects have a short life history. A predator, on the other hand, may go through its life history in a much longer time than its prey. Thus a parasite tends the whole time to gain on its host, whereas a predator does not necessarily do so, and a parasite is of more value as a means of control than a predator. We might instance this in the case of certain tea pests. The gelatine grub (*Belippa laleana*) is very common in the tea gardens, and yet never increases in numbers to any great extent. Our experience in breeding this insect in the laboratory has shown that about eighty per cent. of the caterpillars are parasitised by a small *Hymenopteron*, which keeps the insect under control. There is, on the other hand, a small beetle belonging to the genus *Scymnus* which is predaceous on red spider. This beetle is to be found on almost any garden affected by red spider, and although it undoubtedly does good by devouring large numbers of the pest, yet it is not found to make any appreciable difference in the intensity of an attack. Thus, while both parasites and predators are useful as aids in insect control, the former are the more valuable, if they can be found. It is to be hoped that subsequent research may enable us to discover efficient parasites for the more serious pests of tea, but until that is done no practical suggestions as to the utilisation of such methods of control can be put forward.

We now come to artificial means of insect control, which include mechanical methods such as collecting the insects by hand or by traps, and the use of insecticides. Collection of the insects is not of much value in the case of most pests found in this district, although faggot and bagworms may be dealt with in this manner. It is always of value, however, to make it a rule when forking round bushes, to collect any chrysalids that may be found there, and several instances have come to our knowledge where the regular carrying out of this practice has resulted in a marked decrease of caterpillar attack. Spraying, in this district, should, I think, be done in the cold weather as far as possible, and should take the form of a soda wash or soda emulsion.*

* For Soda Wash see "Notes on the Spraying of Tea," p. 38.
" " Emulsion see ib, pp. 41-43.

Such washes are of immense value in getting rid of the mosses and lichens which cover the bushes here, and which afford shelter to scales of all descriptions and possibly also to the pupal stages of thrips. They also soften the bark, producing a freer and more succulent growth, without which no bush can even be expected to come through an attack of thrips. In addition, these washes are the most valuable insecticides we possess for dealing with scale insects and will kill off individuals of the red spider which take shelter in the crevices of the bark during the cold weather. Spraying in the rains against thrips would appear to be of doubtful value, owing partly to the insect's habit of living inside the buds and curled up leaves and partly to the weather conditions prevailing. In the pamphlet on spraying we have referred to Lefroy's rosin solution, but a few preliminary experiments carried out with species of thrips taken from flowers in the plains appear to show that a nicotine solution is better. Such a solution may be produced by leaving 4 oz. of chopped tobacco leaves in a quart of water over night, warming the solution obtained, and mixing it while warm, with a solution prepared by boiling 4 oz. of soft soap in a pint of water.

The last class of control methods we have to discuss are those which have been described above as cultural methods. This class includes methods of pruning, manuring, cultivation, etc., likely to assist in the control of insect pests. Pruning is a matter to which careful attention should be given in a district such as this where scale insects affect the shoots. These pests prefer wood of a sickly or weakly nature, and any weak shoots left on a bush are likely to be attacked. The attack will weaken the bush, and incidentally will weaken the stronger shoots, which will then be attacked in turn. Shoots very badly attacked should be cut out, and if possible burnt.

Manuring is a matter to which great importance attaches, as incorrect manuring will often lead to a sickly condition of the bush, and render it unable to throw off the attack of insect pests. Good cultivation, also, by strengthening the bushes, will often assist them to resist the attack of insect pests, and forking, by disturbing insects which occur at the foot of the bushes, does a great amount of good. The provision or removal of shade is a method by which

also, some insect pests can be partially controlled. In this district many managers have noticed that thrips is less prevalent under shade, and are planting shade trees accordingly. Others, on the other hand, do not like them because they encourage blister. It is important, however, that suitable shade trees should be planted, but the choice is often determined by the fact that only certain trees will grow. Where they can be persuaded to grow, however, siris trees would seem to be preferable to fullidhas. The latter give a very heavy shade, and are always breaking off. They are also very liable to attack by borers and scales, and instances have been recorded lately of scales getting from them on to the tea in other districts. Rain, instead of dripping evenly from the foliage, pours almost in streams into the bushes, and the leaves, instead of falling on to the ground and forming a mulch, appear, in most instances, to fall into the bushes, where they decompose and form a hot-bed for the development of all kinds of diseases.

RECENT TOURS.

Chief Scientific Officer.

On the 7th of August the Chief Scientific Officer left Tocklai for Doom Dooma and while there visited Koomsong, Bordubi, Budli Beta, and Bokpara estates. On the 9th he addressed a meeting of 43 planters in the Doom Dooma Club, the subject of the address being "The inter-dependence of garden operations." A great many cases come before his notice in all districts of great thought and care being given to one or more particularly of the many garden and factory operations, and he wished to warn planters that it is most important that all operations should be advanced simultaneously, because they are really inter-dependent, and if one operation be neglected or the intensity of that operation be less than that of others, the result looked for will be held back by omitting to carry that operation far enough. Thus for instance pruning and manuring are closely inter-dependent. Intensive pruning is without doubt a more severe check to bushes than a less advanced type of pruning, but if manuring be resorted to in order to promote the formation of new shoots to replace the old and undesirable wood which has been removed in carrying out intensive pruning, the result,—a bush with a bigger, better, more vigorous frame of younger wood—in which pruning and manuring both play an important part will be achieved; and conversely a given expenditure on manures will not prove so profitable where inefficient pruning be done as where the frames of bushes are kept of the right size and shape and as free as possible from undesirable wood and unproductive shoots, by good pruning. Other examples of the inter-dependence of garden operations, such as the connection between manuring and drainage were given to illustrate the point.

This view of manager's work was brought forward particularly in this district because it is one in which there appears to

be no natural feature which can be pointed out as the obvious factor which is limiting crop, and there is a natural balance in conditions, and this must be maintained in treating the bushes artificially. In the Doom Dooma district the conditions of environment are generally speaking as satisfactory as are to be found in any other district. The climate is eminently suitable for tea, being sufficiently forcing in the rains to produce large crops and sufficiently cold and dry in the winter months to have a satisfactory influence on quality. Speaking generally labour is plentiful, and the soil of excellent quality and of that light type which, given plenty of money and labour to expend per acre, is probably the most suitable type of tea soil, and is moreover sufficiently even in character throughout the district to enable planters to form valuable conclusions from the experience derived from work done not only on their own gardens but on those of their neighbours.

The subject of prevention of wash on slopes was also touched upon, and the methods adopted in Java to this end were described in the address. In the short discussion which followed the address it was remarked that to copy exactly the methods of preventing wash employed in Java in a district where the soil was generally so sandy as that of the Doom Dooma district would probably not prove successful. This criticism is a just one, but it would be equally just to pass censure on the very inadequate means taken at present in the Doom Dooma district to prevent wash on those parts of estates (they are not inconsiderable) which are sufficiently sloping to require attention. In a district where labour and money are generally speaking available for work which is seen to be profitable, it seems a pity that a greater effort has not been made to devise a really sound method of treatment of slopes. The suggestion is put forward that a series of well banked-up deep contour drains with bunds on each side and suitable plants growing on the bunds, without the additional drains directly down the slopes which is a feature of the Java system, would be suitable under the conditions. There is now growing at the Tocklai Experimental Station a series of plants which have been purposely chosen with a view to their proving suitable for this purpose, and

the Officers of the Department are very ready to co-operate with such planters as desire to experiment in their use.

On the 12th the Chief Scientific Officer left the Doom Dooma district for Balijan Tea Estate of the Eastern Assam Company and on the 14th he gave an address to seven planters in Dibrugarh. The condition of roads and the station of Dibrugarh itself accounted for the meeting not being large. When in the district the Chief Scientific Officer visited Titadimoro, Greenwood, Maijan, Motala, Borbari, and Romari.

A common feature in this district seems to be the absence of such slopes as are referred to in the above paragraph about Doom Dooma. It is probably the great variety in types of soil that accounts to a great extent for the differences in methods of work which is noticeable in this district in touring from estate to estate.

A large number of soil samples were taken last cold weather from these two districts and these are now being investigated in connection with the Soil Survey. The general similarity of the soils from different estates in the Doom Dooma district has been clearly demonstrated by the mechanical analyses which have already been made. It seems to be the general condition that in parts of the Doom Dooma gardens where the bushes are poorer a heavy subsoil is found to occur at a comparatively short distance from the surface. There also appears to be a tendency for the surface soils, which are generally of the lightest type, with coarse sand predominating and fine sand next in order of importance, to become heavier, that is closer grained, approaching Tinsukia from Doom Dooma. Samples of soil have not yet been taken from the Talup district. Although the Doom Dooma soils are of the lightest type they are by no means the lightest soils which occur within this type, a point which is undoubtedly in their favour. Of the general chemical characteristics of the soils of this district much cannot be said at present, but there is probably an uniformity in keeping with that of the mechanical composition of the soil.

On the 18th and 19th the Chief Scientific Officer visited Moheema Tea Estate and Gotunga garden of the Moabund Tea Co. in the Golaghat district. Of the Golaghat soils much cannot be said

at present except that they are with few exceptions of very heavy types and some of them are intractable in a high dĕgree, while others, particularly those which show a distinctly red tinge, are amenable to careful and correct treatment. There is hardly a garden in this district which does not require heavy liming, and a thoroughly comprehensive scheme of trenching and green cropping, and planting of *Albizzias* and similar trees, should be arranged for as part of the general scheme of garden routine. Heavy pruning carelessly carried out has been far too common a feature in the past of work on gardens of this district.

On the 20th the Chief Scientific Officer left Tocklai for the Suffrai district and visited Napuk, Teok, Borahi, and Suffrai estates. The tilas of red soil in this district form a very interesting feature, and some of the slopes on Suffrai garden have undoubtedly as fine a tea soil as is to be seen anywhere. To the north of this line of tilas there is a heavy soil, some of which approximates in character to rice land soil. Further away from the foot of these tilas the soil is more sandy. The drainage of the gardens below these hills often presents difficulties, partly on account of the existence of the railway, which to some extent acts as a bund, checking the adequate outlet of the water from the foot of these hills. An address was given at the Sonari Club which was attended by eight planters. On the 25th the Chief Scientific Officer proceeded to Amgoorie where he spent three days and saw several gardens of the Company and also visited Tipuk. The soils of these gardens are reddish and shade into black sand. They are probably fairly light in type and are to be classed as good tea soils. The pruning carried out on the Bagjan garden of the Amgoorie Tea Company was examined very carefully and with great interest. An address was given at Amgoorie attended by ten planters. It was a matter of regret to the Chief Scientific Officer that a meeting could not be held at Nazira for there are a considerable number of the Assam Company's gardens in the neighbourhood of Nazira which the Chief Scientific Officer has not yet had the opportunity of visiting. On the 30th the Chief Scientific Officer returned to Tocklai.

On the 4th of October the Chief Scientific Officer left Tocklai on tour in the Golaghat district, visiting Woka, Mokrung, Runga-

jan, Torajan, Latikajan, Numalighur and Borsoporie. An address was given at the Golaghat Club on the 5th which was attended by ten planters. Woka represents a garden which shows the eddish soil which crops out in this district. It has lost its tilth nd is now in a condition in which it requires very careful and ersistent treatment to give it good tilth again. Mokrung has not his red soil, but consists chiefly of a stiff yellow clay which is nore difficult to deal with. There are some very fine patches of oil in the gardens of the Rungajan Company. Great attention as been paid here to shade trees and green cropping and the work as borne fruit undoubtedly in the present condition of tilth which vas generally noticeable. There are some very stiff yellow and greyish clays at Latikajan though in other parts of the estate there are fine red soils of good tilth. Numalighur has a reddish soil capable of attaining excellent tilth.

ENTOMOLOGIST.

During September the Entomologist undertook advisory tours in the Happy Valley, Lakhipur, and North Cachar districts of Cachar, and in the Dam Dim and Chulsa district of the Dooars. The tour in Cachar was, unfortunately, not particularly successful. In the Happy Valley the Entomologist was able to visit Cossipore, Arcuttipore, Majagram, Coombergram, Chandighat, and Pathemara Tea Estates between the 2nd and the 6th of the month, and gave an address at Coombergram on the 4th on the subject of mosquito blight, which was attended by five planters. In the Lakhipur district, where the touring officer was due from the 7th to 9th, he was late owing to arrangements for daks falling through at the last moment, and was only able to visit Dilkhoosh. No meeting had been arranged in this district, and no address was given. North Cachar was visited during the 13th to the 16th of the month, and here an address was given on the 15th, at Kalline Tea Estate, on the subject of mosquito blight. Owing to the state of the roads, only two people were able to attend. From North Cachar the Entomologist travelled *vid* Calcutta to the Dam Dim district of the western Dooars, arriving at Bullabarrie Tea Estate on the evening of the 20th. On the 21st

an address was given, on the subject of mosquito blight, at Bullabarrie, which was attended by twenty-one planters, the Dam Dim and Bagracote districts being afterwards visited from Bullabarrie. The Chulsa district was next visited, the period from the 25th to the 29th being spent there, and an address was given at Samsing Tea Estate, on the subject of mosquito blight, which was attended by sixteen planters. Kumai, Yong Tong, and Nya Sylee gardens were also visited, and on the 29th the Entomologist left for Tocklai.

In Cachar and Sylhet red spider (*Tetranychus bioculatus*) appears to have been more in evidence this season than usual, and one reason for this may have been the excess of moisture present in the soil. Red spider attack is often accentuated by inadequate drainage, and evidence was not wanting to show that in many places the drains had been able to deal with little more than the surface wash, and that soils which in a normal year are fairly well drained, had this year remained in an excessively moist condition for some considerable time. Further, cases were noticed in which the sides of the drains in fine soil had become practically impervious to water, and, although the drains were dry, and there was no water lying about, yet the soil itself contained far more water than should have been the case. Falling rain did not soak through the already saturated soil but ran off the top into the drains. Such a state of affairs is bound to aggravate red spider attack.

A peculiar form of insect attack was seen on a garden in the Happy Valley. A section of tea, the lower portion of which had been flooded, had been attacked by red spider on the older leaves, while thrips had at the same time attacked the flush. The effect of this attack was to give the bush a brown appearance all over, but as the leaves attacked by red spider had turned very dark copper brown, and those attacked by thrips had changed to a more tawny brown, the respective depredations of the two insects were clearly distinguishable at some distance. Mosquito blight was less in evidence than usual in these districts.

In the Western Dooars mosquito blight was fairly bad on certain gardens in the Dam Dim district, and rather less than usual

n gardens in the Chulsa district. One section in a garden which, n the whole, is practically free from mosquito, has been gradually uccumbing to the attacks of the pest, and this year has been very ad. The writer was already in possession of analyses of samples f soil from this garden, taken some years ago, and the manager ery kindly supplied him with a copy of an analysis of a sample ıken from the blighted section recently. The old samples show high percentage of available potash as compared with phosphoric cid, the ratio between the two being as follows :—

$$\text{Sample No. 1} \quad \frac{\text{available potash}}{\text{available phosphoric acid}} = 3{\cdot}222.$$

$$\text{,, ,, 2} \quad \frac{\text{available potash}}{\text{available phosphoric acid}} = 2{\cdot}111.$$

In the sample taken recently from the affected section, how-ver, the ratio is :—

$$\frac{\text{available potash}}{\text{available phosphoric acid}} = 0{\cdot}875.$$

In a previous article* published in this Journal the writer ave figures for Red Bank and grey sandy loam soils which howed that in the former the above ratio is high, in the latter low. 'igures are also given for one Red Bank soil on which the tea is adly blighted, and these show an approximation to the figures for he grey sandy loam.

In the above instance we again find the same approximation, a emarkable confirmation of the theory that the chemical consti-ution of the soil has a great deal to do with the liability of tea to *Telopeltis* attack. When the older samples were taken mosquito light was unknown on the garden. The blight has gradually ncreased, while the ratio between two of the available constituents f the soil has decreased.

In October an advisory tour was carried out in the North akhimpur, Bishnath, and Tezpur districts of Assam. The period rom the 12th to the 18th was spent in North Lakhimpur, the ardens visited being Joyhing, Seajuli, Lillabarrie, Dejoo, Siloni-

* Indian Tea Association, Scientific Department Quarterly Journal, part I, 1914, p. 31-35. The figures referred to are given on page 38.

bari, Doolahat, and Harmutty, and on the 16th an address was given at the North Lakhimpur club on Insect Control, at which twenty-one were present. The Bishnath district was next visited, the Entomologist arriving on the 20th and going through to the Tezpur district on the 28th. Bedetti, Bargang, Mijika, Borpukri, Majulighur, Mouai, and Dekorai were visited during the period, and on the 24th an address was given at Chotapukri club, sixteen being present. In the Tezpur district the gardens visited were, Phulbari, Harchura, Addabari, Bordubi, Modopee, and Sonabheel, and on the 30th an address was given at the Thakurbari club attended by nineteen planters. The tour terminated on the first of November.

The most serious insect pests in the North Lakhimpur district would appear to be white ants, which in many places had done a great deal of damage. Borers are frequently noticed, and the common caterpillar pests, *e. g.*, looper (*Biston suppressaria*), cluster (*Andraca bipunctata*), red slug (*Heterusia magnifica*), faggot and bag worms (*Clania spp.*), etc., are all to be found in the district. In Bishnath *Helopeltis* was very bad this year, and here, as in the Dooars, it is noticeable that the worst affected gardens are on the sandy soils, while gardens on the Red Bank remain, on the whole, comparatively free. While in this district a mango tree standing in a bungalow compound, but overhanging tea badly affected by *Helopeltis theivora*, was noticed, the young foliage of which showed punctures exactly similar to those produced by the above insect. The tree had been badly attacked, and a good deal of the very young foliage was black and shrivelled. After a little search an adult male was found on the tree, and watched for some time, but he was not seen to feed, and flew away while being watched. In order to discover whether the punctures had been made by *Helopeltis*, four were caught in the tea and placed under a tumbler along with a young shoot of mango and a young shoot of tea. Three fed on the mango shoot, one fed on the tea, and the former persisted in feeding on mango, although they had to cross young tea leaves to get to it. There is, therefore, no doubt that *Helopeltis* can, and does, feed on mango trees, although, of course, it was obvious that in this case, at any rate, the insects had gone from the tea to the mango.

The Tezpur district is again, like North Lakhimpur, comparatively free from insect attack, but a good deal of red slug was to be seen in places, and faggot worms were present in much greater number than is usual at this time of year, and were doing a good deal of damage. On one garden a bad attack of what must have been one of the gelatine grubs (*Belippa sp.*) was reported to have occurred a short time previously.

I. O. P.—1100—15-1-1916

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